ROLE OF ASPHALTENE IN CHANGING WETTABILITY OF RESERVOIR ROCK

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INTRODUCTION

Petroleum asphaltenes are high molecular weight constituents of oil comprising polycyclic aromatics or naphthenaromatics with chains usually containing nitrogen, sulphur and oxygen compounds. Asphaltenes are commonly defined as the normal heptane insoluble fraction of crude oil obtained by the Test Method IP 143. The lighter fractions which are soluble in normal heptane but insoluble in ethylacetate at room temperature are known as resins. The basic unit of asphaltene structures are polyaromatic sheets which are stacked by molecular associations to form particles. Several particles may aggregate to form micelles of different sizes ranging from 500 to 500,000 sheets. The mechanism of asphaltene precipitation is very complex and not well understood.

Wettability as applied to an oil reservoir describes the tendency of a fluid to adhere or spread to a solid surface in the presence of another immiscible fluid. It can be described as a measure of the affinity of the rock surface for the oil or water phase. A major role of wettability in a reservoir is that of determining the location and distribution of reservoir fluids that influence reservoir-fluid relative permeabilities and thus recovery efficiency [1,2].

Certain fraction of crude oil constituents are believed to be capable of reacting with the reservoir rock surface. Several researchers have indicated that the wettability of a reservoir is strongly related to the amount of adsorption of asphaltenes material found in certain crude oils [3,4]. It is now known that many reservoirs are not water-wet as previously been assumed. Due to several reasons oil reservoirs are found to have oil-wet or mixed wettability [5]. One of the reasons is the adsorption of asphaltenes material on the rock. This paper reports an investigation on the precipitation and adsorption of aspahaltene on reservoir rock and other minerals. The effect of asphaltene adsorption on water-oil distribution and oil transport in reservoir rock is also reported.

EXPERIMENTAL WORK

Asphaltene adsorption from toluene solution on different rock minerals were measured. The asphaltene adsorption were both measured on surface area basis. The different mineral surface used were berea, limestone, dolomite, and kaolin. Contact angles of a water droplet on clean glass and on asphaltene treated glass were measured. In another experiment asphaltene solution in toluene was injected into etched glass micromodel. The micromodel was then aged at 75 ^{0}C for seven days. At the end of the period the micromodels was rinsed with water and the micromodels was observed under microscope. Immiscible displacement experiments using clean water-wet micromodel and micromodel already aged in asphaltene solution were carried out. The oil and water distribution in both micromodels were compared and the transport of fluids was visualised and recorded. The detail experimental work and results were discussed in Reference [6].

RESULTS

The amount of asphaltene adsorbed from toluene solution on different rock mineral is shown in Figure 1. The minimum adsorption occured in berea and the maximum adsorption occured in limestone. For berea the asphaltene adsorbed is about 0.8 mg/m^2 of substrate and for limestone is about 1.8 mg/m^2 of substrate. The asphltene adsorbed in kaolin, berea containing clay and in dolomite was between those two values.

The contact angle (measured on advancing mode) on clean glass surface was 15 degrees while on the asphaltene treated surface was 120 degrees. Thus the wettability of the glass surface has been altered from water-wet to oil-wet by the asphaltene adsorption on the glass surface.

Visualisation under microscope of micromodel which has been treated with asphaltene solution showed some brown spots. These spots are locations where the

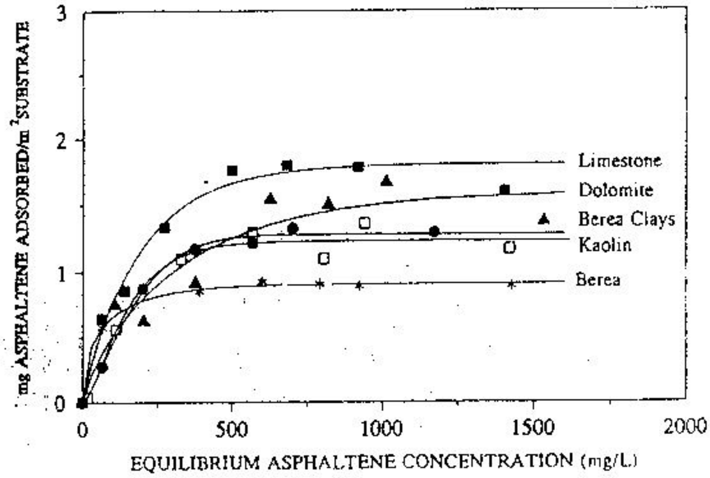

Figure 1: Asphaltene adsorption of different rock minerals from toluene solutions, surface area basis

asphaltene has been precipitated and adsorbed on the pore surface (Figure 2). But the precipitation has not occured throughout all the surface. Some surface remain clean or free of asphaltene precipitation. The distribution of water and oil in the pores has indicated that the surface has affinity for water and oil at different locations. This indicates that fractional wettability has been generated within the micromodel (Figure 3). Oil recovery by water displacement has been conducted

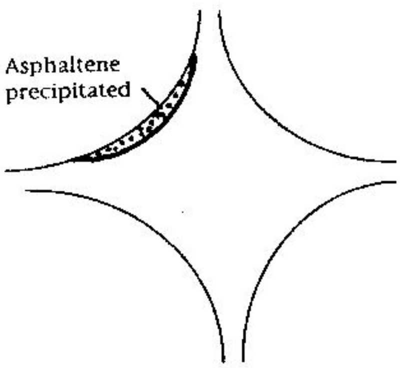

Figure 2 : Asphaltene precipitated on some pore surface

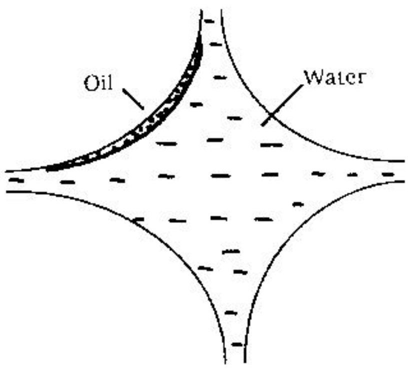

Figure 3 : Oil adhered to surface which had adsorbed asphaltene

using the clean micromodel and the treated micromodel. Oil recovery at two pore volumes of water injection in water-wet and in fractional-wet micromodel was approximately 90% and 70% respectively.

DISCUSSIONS

The results of the study has shown that asphaltene can play a major role in controlling the wettability of reservoir rock. In waterflood the presence of asphaltene has a negative effect on oil displacement efficiency. Thus a method must be determined to inhibit the precipitation and adsorption of asphaltene in reservoir rock especially near the well bores. Research to determine the most suitable inhibitor of asphaltene precipitation at reservoir conditions should be done.

CONCLUSIONS

1. Asphaltene can be adsorbed by different amount for different rock mineral. The adsorption of asphaltene alters the glass and berea surface from water-wet to oil-wet.
2. When only partial precipitation of asphaltene has occured on the surface of the pores then fractional wettability has been generated.
3. Oil recovery by waterflood is more efficient in water-wet rock than in fractional-wet rock.

ACKNOWLEDGEMENTS

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